CHAPTER 5

CUMULATIVE ENVIRONMENTAL IMPACTS OF THE DOMESTIC PROGRAMMATIC ALTERNATIVES

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Chapter 5 presents the cumulative environmental impacts of the domestic programmatic alternatives assessed in this Global Nuclear Energy Partnership (GNEP) Programmatic Environmental Impact Statement (PEIS). The potential cumulative impacts are based on the potential environmental impacts of the GNEP PEIS alternatives together with those of other past, present, and reasonably foreseeable future actions.

5.1 INTRODUCTION

The Global Nuclear Energy Partnership (GNEP) program is proposing to make decisions that would support new nuclear power generation in the United States. This Chapter assesses the potential cumulative environmental impacts in the United States of such new nuclear capacity. Chapter 4 of this Programmatic Environmental Impact Statement (PEIS) analyzes four growth scenarios for nuclear electricity capacity: zero growth (100 gigawatt-electric [GWe]); 1.3 percent annual growth (200 GWe); 0.7 percent annual growth (150 GWe); and 2.5 percent annual growth (400 GWe), including the construction and operation of new facilities, the replacement of existing plants, and the infrastructure necessary to support those plants, including mining, uranium enrichment and fuel fabrication facilities, and waste storage and disposal. This section describes the potential cumulative impacts associated with the programmatic alternatives when added to the impacts of other past, present, and reasonably foreseeable future actions. The analysis focuses on cumulative impacts to water, electricity supply and demand, radiological wastes, transportation, land use, air quality and greenhouse gases, and construction materials.

The approach to cumulative impacts analysis in this chapter is influenced by the nature of the programmatic alternatives. Implementation of any programmatic alternative would take several decades and impacts would be experienced over a long period of time (well beyond 50 years). Implementation could involve hundreds of new facilities. The U.S. Department of Energy (DOE), however, is not proposing to site, construct, or operate any particular facility; thus, impacts can not be analyzed for any specific location and, as Chapter 3 describes, the affected environment includes the entire United States, with emphasis on the contiguous 48 states[1].

The Council on Environmental Quality guidance for cumulative impacts analysis states that an EIS should identify cause-and-effect relationships for specific resources, ecosystems and communities (CEQ 1997a). The analysis in this chapter provides the reader a view of reasonably foreseeable actions within the United States over approximately the next 50 years. It is therefore not possible to identify the cumulative impacts on some specific locations, resources, ecosystems, or communities for actions associated with the domestic programmatic fuel cycle alternatives discussed in Chapter 4. By necessity, this analysis is of a broader context, and takes

[1] Separately, Chapter 7 provides a qualitative analysis of the potential environmental impacts on the global commons and potential cumulative impacts in the United States of GNEP international initiatives, including a Reliable Fuel Services Program.

into account the impacts of actions taking place within the entire United States in the foreseeable future (typically about 50 years—consistent with the analysis in Chapter 4). Potential cumulative impacts from the incremental contribution of the alternatives are assessed according to their potential locations, time frame of occurrence, and impact intensity when added to other reasonably foreseeable activities, projects, or plans.

5.1.1 Methodology for Assessing Cumulative Impacts

The methodology adopted to determine the potential cumulative impacts is as follows:

The region of influence is the geographic area of affected resources and the distances at which impacts associated with the alternatives may occur. Because this PEIS does not assess specific locations for any of the alternatives, the region of influence for the cumulative impacts analysis is the United States. Use of the entire United States is required because the specific locations of future nuclear power generating facilities and other potential facilities associated with any of the domestic programmatic alternatives is unknown. The geographic boundaries of areas of concern within the United States may vary based on the distance at which an impact may occur.

1. The time frame for this analysis generally extends through the next 50 years approximately. However, impacts on some resources, such as those affected by longer term storage or additional geologic repository capacity, could continue far beyond 50 years. To the extent practicable, this PEIS considers these longer-term cumulative impacts.

2. Reasonably foreseeable future actions are identified. These include trends that could affect environmental impacts within the United States over the next 50 years approximately. Reasonably foreseeable future actions are identified and listed in Table 5.1.2-1 and are described in Section 5.1.2.

3. Baseline conditions of natural resources and human receptors are characterized in Chapter 3.

4. Cumulative impacts on the resources and receptors are analyzed by considering the impacting factors due to the alternatives and their incremental contribution in the foreseeable future. The potential cumulative impacts on resources are described in Section 5.2.

5.1.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions include all the probable impacts of the activities, projects, or trends on the human and environmental resources within the defined time frame. As a part of the cumulative impact analysis, Table 5.1.2-1 presents the types of future actions that have been identified as reasonably foreseeable in the United States over approximately the next 50 years (until approximately 2060).

TABLE 5.1.2-1—*Reasonably Foreseeable Future Actions in the United States*

Types of Actions	Associated Activities and Facilities
Population Growth	– Increased water demand – Increased electricity demand – Increased transportation demand – Increased land use – Increased air quality impacts – Increased use of construction materials
Technology Development	– Changes in water demand, use, and supply – Changes in electricity demand, use, and supply – Changes in transportation demand, use, and infrastructure – Changes in land use – Changes in air quality impacts – Changes in construction materials

Technology developments in the foreseeable future are expected to change the way citizens in the United States (and around the world) live and work. These changes could, in turn, affect impacts to the environment. New technologies and devices would likely transform manufacturing, computing, human health, transportation, and energy infrastructure. Technology changes in the next 50 years would ultimately depend on how new technologies are managed, adopted, and implemented. Economics and regulatory requirements would be expected to weigh heavily on these issues. While acknowledging that future changes could be significant, this PEIS does not identify or assess any specific technology developments that could produce these changes. Rather, this PEIS discusses general technology development and correlates reasonably foreseeable future changes based on past changes and trends. Technology development could affect water, electricity supply and demand, transportation, land use, and air quality as explained in the sub-sections below.

5.1.3 Population Growth

According to the U.S. Census Bureau, the current population in the United States is approximately 303 million people (USCB 2008a). The U.S. Census Bureau projects that the United States population would increase by approximately 0.9 percent annually until 2014. Between 2015 and 2035, the U.S. Census Bureau expects the United States population to increase by approximately 0.8 percent annually, and then to increase by 0.7 percent annually between 2036 and 2050 (USCB 2008b). For this cumulative impact analysis, a 0.7 percent growth rate is assumed to continue after 2050 until approximately 2060, which is the approximate end point analyzed in this PEIS. Based on those increases, the total population in the United States would increase from approximately 303 million to approximately 450 million by the year 2060 (see Table 5.1.3-1). This PEIS notes that the forecast future population would be highly subject to behavioral decisions by individuals, possible unexpected developments in health and morbidity, and policy decisions by governments nationally and internationally. Population growth would cause impacts to water, electricity, transportation, land use, air quality, and the use of construction materials as explained in the sub-sections below.

TABLE 5.1.3-1—*Projected Future United States Population*

Year	Number (1,000)	Percent Change	Year	Number (1,000)	Percent Change	Year	Number (1,000)	Percent Change
2004	292,801	0.9	2023	343,921	0.8	2042	397,519	0.7
2005	295,507	0.9	2024	346,669	0.8	2043	400,301	0.7
2006	298,217	0.9	2025	349,439	0.8	2044	403,081	0.7
2007	300,913	0.9	2026	352,229	0.8	2045	405,862	0.7
2008	303,598	0.9	2027	355,035	0.8	2046	408,646	0.7
2009	306,272	0.9	2028	357,862	0.8	2047	411,435	0.7
2010	308,936	0.9	2029	360,711	0.8	2048	414,230	0.7
2011	311,601	0.9	2030	363,584	0.8	2049	417,035	0.7
2012	314,281	0.9	2031	366,466	0.8	2050	419,854	0.7
2013	316,971	0.9	2032	369,336	0.8	2051	422,793	0.7
2014	319,668	0.9	2033	372,196	0.8	2052	425,752	0.7
2015	322,366	0.8	2034	375,046	0.8	2053	428,733	0.7
2016	325,063	0.8	2035	377,886	0.8	2054	431,734	0.7
2017	327,756	0.8	2036	380,716	0.7	2055	434,756	0.7
2018	330,444	0.8	2037	383,537	0.7	2056	437,799	0.7
2019	333,127	0.8	2038	386,348	0.7	2057	440,864	0.7
2020	335,805	0.8	2039	389,151	0.7	2058	443,950	0.7
2021	338,490	0.8	2040	391,946	0.7	2059	447,058	0.7
2022	341,195	0.8	2041	394,734	0.7	2060	450,187	0.7

Source: USCB 2008b for data through 2050, data from 2050 to 2060 derived from USCB 2008b

5.2 CUMULATIVE IMPACTS

5.2.1 Water

Population increases would be expected to increase the demands on water resources. Water use estimates in the United States indicate that about 408 billion gallons per day (gal/day) (1.5 trillion liters per day [L/day]) were withdrawn for all uses during 2000. This total is about 3 percent more than 1985, as withdrawals have stabilized for the two largest uses (i.e., irrigation and thermoelectric power) since the year 1990. Fresh groundwater withdrawals during 2000 were 83.3 billion gal/day (315 billion L/day), which is about 14 percent more than during 1985. Fresh surface water withdrawals for 2000 were 262 billion gal/day (992 billion L/day), varying less than 2 percent since 1985 (USGS 2004a).

Total household water consumption in the United States was approximately 6.3 billion gal (23 billion L) in 1995, and is projected to be approximately 10 billion gal (38 billion L) by 2025. The United States will be responsible for more than 10 percent of the global household water consumption in 2025 (IFPRI 2002). Water problems in the foreseeable future could include contamination of ground water, depletion of underground aquifers, salinization of irrigation water, siltation of impoundments, prolonged drought, and frequent flooding.

The amount of water consumption in the United States is projected to rise both due to population growth and greater per capita use. For purposes of this PEIS cumulative impact analysis, it is assumed that future increases in water use would be similar to the increases that have occurred since 1985 (3 percent increase over approximately 15 years, which equates to an annual growth rate of approximately 0.2 percent). Based on this growth rate, the United States water consumption is projected to increase to approximately 460 billion gal/day (1.7 trillion L/day) by approximately 2060.

Technology development could affect water use in the United States. According to data from the U.S. Geological Survey (USGS), agriculture is the largest user of fresh water, followed by electricity generation (NETL 2004). Because agriculture needs are largely driven by population demands, water use for agricultural use should grow commensurate with the population. While technology developments could improve the efficiency of agricultural use of water, it would be speculative to assign a specific value to such improvement.

For the 200 GWe scenario, the alternatives in this PEIS would use approximately 3.3 billion gal/day (12.2 billion L/day), based on the use of approximately 6 billion gal/year (24 billion L/year) for each GWe of energy produced. Compared to the 460 billion gal (1.7 trillion L) of water that would be used daily by other sources in 2060, the alternatives in this PEIS would use approximately 0.7 percent of the water used in the United States. Approximately 99 percent of the water withdrawn for cooling would be returned to its source. The U.S. Census Bureau projections recognize increased growth rates in the southern and western United States, relative to the other regions. This would accentuate the demand for water in these two regions. Water resources are regionally sensitive in that not all regions have the same water availability. This is further complicated by other, larger water resources which are shared by several regions.

With respect to electricity generation, power plants' water requirements would likely rise as demand for electricity grows over the next five decades. However, the amount of water needed to generate each unit of electricity would likely decrease because companies are expected to install new technologies that require less water (e.g., the use of dry cooling technologies can reduce water use requirements by more than 90 percent for a typical 1 GWe electrical-generating facility). Power plants consume only about 3 percent of the water they draw from a particular source while generating electricity. To generate electricity, most power plants burn a fuel to heat water and create steam. It is estimated that by 2020 power plants would need between 94 billion gal (356 billion L) less water (a reduction of 3 percent) per year and 576 billion gal (2.2 trillion L) more water (an increase of 17 percent) to meet future electricity demand (GAO 2002). The lower estimate assumes that all the additional demand would be met with dry cooling technology, while the higher number assumes that it would be met with wet cooling systems. Plants will likely use a combination of the two systems. Regardless, newer technologies will allow plants to consume less water per unit of electricity produced than they currently do, having less of an impact on the environment in the foreseeable future (GAO 2002).

5.2.2 Electricity

Electricity demands are a function of both population increases and economic growth. Electricity use in the United States is expected to continue to grow. In its most recent *Energy Outlook Report*, issued in June 2008, the Energy Information Administration (EIA), an independent organization within DOE, estimates that demand for electricity will increase by approximately 1.1 percent annually through 2030 (EIA 2008a). An early release of that report, issued in December 2007, estimated United States electricity growth at 1.3 percent annually through 2030

(EIA 2007a). This Draft PEIS utilizes the higher 1.3 percent growth rate; however, in the Final PEIS, DOE will consider whether any changes to the document are warranted to account for the 1.1 percent growth rate or other relevant information that becomes available. Based on an annual growth rate of 1.3 percent, electricity use could increase by approximately 40 percent by 2030, and if that annual rate were to continue, electricity use could double (relative to use in 2004) by approximately 2060.

Currently, there is approximately 487 GWe of installed electrical generating capacity in the United States. Of this, nuclear power accounts for approximately 19 percent of the total electricity supply, while 70 percent comes from fossil burning fuels (coal, natural gas, and oil) (EIA 2008a). Assuming that future electricity demands would increase by approximately 1.3 percent annually, by approximately 2060 the United States would need to have an installed capacity of approximately 929 GWe. This would equate to a need for approximately 442 GWe of new electrical-generating capacity. Depending upon the energy sources used to supply this capacity, new electrical-generating capacity would affect land use, water use, air quality, biological resources, the visual environment, wastes generated, the transportation infrastructure, human health, global climate, and socioeconomics. The specific impacts associated with increased electrical supply and impacts to the electrical distribution network would be highly dependent upon the locations for any new electrical generating capacity, which are unknown.

Technology improvements could affect both electrical production and demand. Either of these could result in improvements in electricity generation. On the production side, the efficiency of electricity production is expected to continue to improve over time, as it has in the past. This is illustrated by the fact that plant capacity factors have risen in the past and will likely continue to increase. This is primarily due to improved technologies and improved maintenance practices. There is, however, a theoretical limit as to how high capacity factors can rise, and in the future it is expected that improvements in capacity factors will not be as great as in the past as the theoretical limit is approached. Future improvements in capacity factors would result in less need for new electrical-generating plants. Technology improvements could have a more meaningful affect on the electricity demand side. For example, by 2020, all light bulbs sold in the United States must be 70 percent more efficient than current bulbs (42 U.S.C. 6291). However, even with these technology improvements, electrical demand will be primarily driven by population increases and economic growth.

5.2.3 Spent Nuclear Fuel and Radioactive Waste

The alternatives in this PEIS would contribute to cumulative amounts of spent nuclear fuel (SNF) and radioactive wastes that would require management and disposal. This section discusses the following materials: 1) spent nuclear fuel and high-level radioactive waste; 2) Greater-than-Class-C low-level radioactive waste; and 3) low-level radioactive waste.

The *Nuclear Waste Policy Act* of 1982, as amended, provides for the disposal of commercial spent nuclear fuel and DOE spent nuclear fuel and high-level radioactive waste in the Nation's first proposed geologic repository to be located at Yucca Mountain, Nevada. The *Nuclear Waste Policy Act* limits the initial capacity of Yucca Mountain to 70,000 MTHM of spent nuclear fuel and high-level radioactive waste until such time as a second repository is in operation (42 U.S.C. 10101 et seq.). DOE has allocated this capacity between 63,000 MTHM of commercial spent nuclear fuel and 7,000 MTHM of DOE spent nuclear fuel and high-level radioactive waste. Disposal of more than 70,000 MTHM of spent nuclear fuel and high-level radioactive waste at the Yucca Mountain site prior to completion of a second repository would require a legislative change.

In its cumulative impacts analysis, the Yucca Mountain Supplemental Environmental Impact Statement (SEIS) (DOE 2008f), issued in June 2008, evaluated the disposal of up to approximately 130,000 MTHM of commercial spent nuclear fuel,[2] equivalent to the amount projected from all existing commercial power reactors during all of their projected lifetimes. The Yucca Mountain SEIS also evaluated an alternative disposal case in which DOE would dispose of 63,000 MTHM of commercial spent nuclear fuel as spent fuel, as in the Yucca Mountain SEIS proposed action, but the balance of this commercial spent nuclear fuel inventory (approximately 67,000 MTHM) would be recycled and the resultant high-level radioactive waste would be transported to and disposed of at the Yucca Mountain geologic repository. This amount of commercial spent nuclear fuel (i.e., approximately 67,000 MTHM) also is a part of the commercial spent nuclear fuel inventory evaluated in the GNEP programmatic alternatives.

For the 200 GWe scenario, the GNEP closed fuel cycle alternatives could generate between 18,000 and 55,000 cubic meters of high-level radioactive waste that would require disposal in a geologic repository. (In addition, the Thermal Reactor Recycle Alternative (Option 2), while considered a closed fuel cycle alternative, could generate approximately 71,000 MTHM spent nuclear fuel.)[3] For the 200 GWe scenario, the GNEP open fuel cycle alternatives could generate between 99,000 and 280,000 MTHM spent nuclear fuel that would require disposal in a geologic repository.

Independent of the domestic programmatic alternatives, DOE is preparing an Environmental Impact Statement for the Disposal of Greater-than-Class-C Low-Level Radioactive Waste (DOE/EIS-0375) (72 FR 40135). DOE estimates that approximately 2,600 cubic meters of Greater-than-Class-C low-level radioactive waste will require management nationwide (72 FR 40135). In addition, DOE estimates that there will be certain wastes that will be generated from DOE activities which may not have an identified disposal path and will have characteristics similar to Greater-than-Class-C low-level radioactive waste. This DOE waste is estimated to be 3,000 cubic meters (72 FR 40135). Thus, the total Greater-than-Class-C low-level radioactive waste that will require management is projected to be 5,600 cubic meters. For the 200 GWe scenario, the GNEP closed fuel cycle alternatives could generate 9,700 to 416,500 cubic meters of Greater-than-Class-C low-level radioactive waste, while the open fuel cycle alternatives (including the No Action Alternative) could generate approximately 2,500 cubic meters. (The estimates DOE has developed for the GTCC EIS, as well as the estimates developed for the GNEP programmatic alternatives, include the quantities of Greater-than-Class-C low-level radioactive waste that would be generated from the decontamination and decommissioning of existing light water reactors.) Consequently, the closed fuel cycle alternatives would account for approximately 64 to 99 percent of the total

[2] The Yucca Mountain SEIS cumulative impacts analysis also evaluated the disposal of all DOE spent nuclear fuel (approximately 2,500 MTHM) and all DOE high-level radioactive waste (approximately 36,000 canisters).
[3] Insufficient data exists to estimate the amount of spent nuclear fuel from the Thermal Reactor Recycle Alternative (Option 3).

Greater-than-Class-C low-level radioactive waste, while the open fuel cycle alternatives would account for approximately 31 percent of the total Greater-than-Class-C low-level radioactive waste (see Table 5.2.3-1).

In 2005 and 2006, the total amount of low-level radioactive waste disposed of at the three commercial disposal facilities in the United States was approximately 113,000–115,000 cubic meters annually (NRC 2007g, MIMS 2008). Of this low-level radioactive waste, in 2006, approximately 52,500 cubic meters was related to nuclear-generated electricity and 62,000 cubic meters was unrelated to nuclear-generated electricity (MIMS 2008). Assuming that low-level radioactive wastes unrelated to nuclear-generated electricity would continue at this rate, over the next 50 years, approximately 3,100,000 cubic meters of low-level radioactive waste would require disposal. For the 200 GWe scenario, the GNEP closed fuel cycle alternatives[4] could generate approximately 1,740,000–2,895,000 cubic meters of low-level radioactive waste, or approximately 36–48 percent of the total low-level radioactive waste that would require disposal (see Table 5.2.3-1). The open fuel cycle alternatives would generate approximately 150,000–585,000 cubic meters of low-level radioactive waste, or approximately 516 percent of the total low-level radioactive waste that would require disposal (see Table 5.2.3-1). As a result of recycling spent fuel, the closed fuel cycle alternatives generate much higher quantities of low-level radioactive waste. All of the estimates of low-level radioactive waste quantities assume that future reactors would generate low-level radioactive waste in quantities similar to existing commercial reactors.

Table 5.2.3-1—*Cumulative Impacts of Radioactive Waste Generation*

	Greater-Than Class-C Radioactive Waste (cubic meters)	Low-Level Radioactive Waste (cubic meters)
	Closed Nuclear Fuel Cycle Alternatives	
Non-GNEP Inventory	5,600	3,100,000
GNEP[a]	9,700 to 416,500	1,740,000 to 2,895,000
TOTAL	15,300 to 422,100	4,840,000 to 5,995,000
Percent of Total Waste Attributed to GNEP	64 to 99	36 to 48
	Open Nuclear Fuel Cycle Alternatives	
Non-GNEP Inventory	5,600	3,100,000
GNEP[a]	2,500	150,000 to 585,000
TOTAL	8,100	3,250,000 to 3,685,000
Percent of Total Waste Attributed to GNEP	31	5 to 16

[a] Data from Table 4.8-6, Comparison of Domestic Programmatic Alternatives for 200 GWe (Cumulative Impacts, 50 years of implementation). The waste volumes represent the range among the highest and lowest estimated amounts for the various alternatives within the closed and open fuel cycles.

5.2.4 Transportation

Nonradiological. Given the trends in population growth and related trends of increased industrial, commercial, and residential development, incremental increases in road traffic are likely for the United States in the foreseeable future. Demand for transportation is expected to be proportional to urban activities, economic growth, and population growth. For purposes of this

[4] Thermal Reactor Recycle Alternative (Option 2) not included due to lack of data for DUPIC fuel fabrication facility.

PEIS cumulative impact analysis, it is assumed that future demands on the transportation infrastructure would be directly proportionate to population growth and could be expected to grow by approximately 48 percent by the year 2060. These increased demands would require expansion of the U.S. transportation system, including the building of new roads, expansion of existing roads, and new interstate systems, airports, and other transportation systems. This would affect land use, water use, air quality, biological resources, the visual environment, human health, and socioeconomics. The specific impacts associated with expanding the U.S. transportation system would be highly dependent upon demographics and the associated localized demands, which are unknown. This PEIS acknowledges that improvements in, and expansions of, mass transit systems could mitigate impacts, but without specific proposals it is not possible to quantify how these initiatives could change the overall demands on the U.S. transportation infrastructure.

Development of more efficient transportation systems (e.g., cars, trains, airplanes, and mass transit) is expected to continue in the foreseeable future. Research and development could make possible the availability of drastic advancements in transportation technology. These new transportation technologies may lead to improvements in transportation efficiency, safety, and emissions, such as lightweight recyclable materials and catalysts for reducing exhaust pollution in the future. Increased research could also lead to the development of vehicles capable of up to three times greater fuel efficiency.

The alternatives in this PEIS would not have any meaningful effect on nonradiological transportation activities in the United States and would not contribute to cumulative impacts. In addition, funding for transportation projects is a political issue occurring at many levels and resulting in disproportionate regional expenditures regardless of growth. This would be expected to accentuate regional disparities in transportation infrastructure investment, over time.

Radiological. The *Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (hereafter The Yucca Mountain Final SEIS) (DOE 2008f) includes a detailed analysis of the cumulative transportation impacts associated with past, present, and future radiological shipments (including SNF and high-level radioactive waste to be disposed of at the Yucca Mountain repository). That analysis includes consideration of impacts from 1943 through 2073 (which falls within the approximate endpoint for implementation [2060-2070] in this GNEP PEIS). Based on the Yucca Mountain Final SEIS cumulative impact analysis, DOE estimated the cumulative transportation impacts shown in Table 5.2.4-1.

TABLE 5.2.4-1—*Potential Cumulative Transportation Impacts*

	Worker Dose		General Population Dose		Traffic Fatalities[a]
	person-rem	LCF	person-rem	LCF	
Collective dose and traffic fatalities of non-GNEP transportation					
Historical DOE shipments and reasonably foreseeable actions[b]	28,000	17	49,000	29	94
General radioactive material transportation (1943 to 2073)[c]	350,000	210	300,000	180	28
Yucca Mountain estimated impacts[d]	5,600–5,900	3	1,100–1,200	1	3
Subtotal of non-GNEP transportation impacts	380,000	230	350,000	210	130
GNEP Alternatives (Low values are for No Action Alternative, Truck and Rail Scenario [f]; High values are for All-HTGR Alternative, Truck Scenario[e]	450–270,000	0–160	1,540–1,400,000	1–820	3–150
Total Collective Transportation Impacts	380,000–650,000	230–390	350,000–1,800,000	210–1,000	130-280

Source: DOE 2008f, Table 8-14

[a] The values provided in this column represent the number of expected vehicular accident fatalities. Additional fatalities due to release of radioactive materials are less than one percent of these impacts; therefore, these are not included. For comparison, there could be 28 expected fatalities over the 131-year period (1943–2073) based on the NRC traffic fatality rate of 0.213 traffic fatalities per year from radioactive material shipments (NRC 1977b).

[b] The values provided in this row represent all known historical DOE shipments, starting in 1943 (the year operations began at the Hanford Site and Oak Ridge Reservation) and all reasonably foreseeable actions involving transportation of radioactive materials through 2073 (the assumed end date for Yucca Mountain shipments) provided in other NEPA documents. The values are based on in-transit impacts only. Table 8-14 of DOE 2008f is the source of the data provided.

[c] This row represents an estimated collective dose due to transport of eight categories of radioactive materials [1) industrial, 2) radiography, 3) medical, 4) fuel cycle, 5) research and development, 6) unknown, 7) waste, and 8) other]. The values are based on in-transit impacts only.

[d] Values provided represent the Yucca Mountain Supplemental EIS proposed action. The values are based on in-transit impacts only. Source: DOE 2008f, Table 8-14.

[e] The All-High Temperature Gas-Cooled Option, Truck Scenario represents the maximum estimated transportation impacts of the programmatic alternatives analyzed in the GNEP PEIS. The values are based on in-transit impacts only. Source: Table 4.8-13.

[f] The No Action Alternative, Truck and Rail Scenario represents the minimum estimated transportation impacts of the programmatic alternatives analyzed in the GNEP PEIS. The values are based on in-transit impacts only. Source: Table 4.8-14.

Note: Numbers are rounded to two significant figures; therefore, totals may differ from sums.

5.2.5 Land Use

The U.S. population growth would lead to increased land development. This would disturb land that is currently undisturbed or used for other activities such as ranching and agriculture. As discussed in Chapter 3, land area of the continental United States covers about 1.94 billion acres (785 million hectares [ha]). Of this, developed land accounts for approximately 108 million acres (44 million ha) (approximately 5.6 percent of the total land area). Assuming that future land use requirements would be proportionate to population increases, the amount of developed land could increase to approximately 160 million acres (64 million ha) by approximately 2060. Increased land development could affect air quality, the visual environment, biological resources, human health, and socioeconomics. The specific impacts associated with increased use would be highly dependent upon the locations disturbed, which are unknown.

Urban land use in the United States continues to increase as the population increases and the economy expands. This trend is expected to continue in the foreseeable future. Besides providing many social and economic benefits, changes in land use patterns would continue to have impact on the natural environment. The role of technology as a potential cause of past and prospective changes in land use can be significant. Technological development can alter the usefulness and demand for different natural resources. The extension of basic transport infrastructure such as roads, railways, and airports, is estimated to open up previously inaccessible resources and lead to their exploitation and degradation in the future. Technological developments and their application such as improvements in methods of converting biomass into energy, use of information-processing technologies in crop and pest management, and the development of new plant and animal strains through research in biotechnology may lead to major shifts in land use in the foreseeable future (Brouwer et al. 1991).

The alternatives in this PEIS could result in land disturbances of approximately 600,000 acres (243,000 ha) for the 200 GWe scenario. Future land use requirements associated with population growth are projected to result in the development of approximately 52 million acres (21 million ha) by approximately 2060 (from 108 million acres to 160 million acres [44 million to 65 million ha]). Consequently, the land use impacts from the PEIS alternatives would account for less than a 1.5 percent increase compared to the land use associated with population growth.

5.2.6 Air Quality and Greenhouse Gases

Regional air quality is primarily a function of pollutant emission levels in the nearby area. Air quality is generally much lower in urban and highly industrialized areas where a large number of pollutant emission sources are present in a relatively small area. To a lesser extent, weather patterns, topography, vegetation cover, and state air quality standards can affect regional air quality. As shown on Figure 3.2.1-1, most regions of the United States currently satisfy the National Ambient Air Quality Standards (NAAQS). Increased population would lead to increased impacts on air quality. Increased urban sprawl and industrialization would change visibility, and increase impairment in Class I areas, trace metal deposition, mercury dispersion and bioaccumulation, and atmospheric greenhouse gas levels. Adverse air quality impacts would result from a large number of mobile and stationary sources across a wide geographic domain.

Operation of some energy sources would generate greenhouse gas emissions and thus incrementally contribute to global atmospheric levels of these gases. Increased traffic and transportation demands would also contribute to incremental impacts on air quality. In 2006, the total U.S. carbon dioxide (CO_2) emissions from all sources were 5,935 million metric tons (MT). Carbon dioxide emissions in 2006 from power generation were approximately 2,344 million MT. Approximately 83 percent of this (1,938 million MT) was due to electricity generation from coal, and 15 percent (340 million MT) was due to electricity generation from natural gas (EIA 2007m).

Technology development could improve air quality by reducing the emissions from power plants and transportation systems. Most recent data shows that the United States produces about 22 percent of global carbon dioxide emissions, primarily because the United States economy is the largest in the world and the United States meets most of its energy needs through burning fossil fuels. While technology developments (e.g., low- and zero-emission vehicles and carbon sequestration for coal plants) could reduce the emissions in both the transportation and energy sectors, CO_2 emissions in the United States are projected to continue rising (EIA 2007m).

The alternatives in this PEIS could have a positive impact on air quality and greenhouse gas emissions as nuclear power generation of electricity could replace a similar amount of fossil fuel generation of electricity. For every GWe produced by nuclear power, approximately 2,000,000 MT of CO_2 (typical coal plant) or 1,000,000 MT of CO_2 (typical natural gas plant—see Section 4.1.8) would not be emitted (assuming such plants were not engaging in carbon sequestration) (EIA 2001).

5.2.7 Construction Materials

Population increases would directly affect the use of construction materials such as steel and concrete. As shown in Chapter 3, the United States annually uses about 120 million MT of steel and 120 million MT of concrete. Population increases would require more housing, roads, office buildings, and other infrastructure. Assuming that the annual use of steel and concrete would be proportionate to increases in population, the United States could expect that the use of both steel and concrete would grow to approximately 178 million MT, each, in about 2060.

Although technology development could affect the use of construction materials such as steel and concrete, through the wider use of composite materials and new products, any effects would be difficult to quantify without understanding the nature of the technological development. As such, this PEIS does not estimate any changes in steel or concrete use due to technology developments but recognizes the potential to diminish requirements based on current construction material technology.

The alternatives in this PEIS could result in the construction of more than 200 major nuclear facilities for the 200 GWe scenario over the approximate 50-year time period assessed. As described in Chapter 3, material requirements for a nuclear power plant would vary by design and site location, but requirements for a typical 1 GWe nuclear plant would include approximately 150,000 MT of steel and 850,000 MT of concrete. Constructing approximately 200 major new nuclear facilities over approximately 50 years would result in an average of 4 new major nuclear facilities annually. On an annual basis, these new nuclear facilities would use approximately 600,000 MT of steel and 3.4 million MT of concrete. Compared to the current usage of steel and concrete, these increases would amount to less than 1 percent (steel) and 2.8 percent (concrete).

5.2.8 Impacts Beyond 50 Years

Actions taken based on this PEIS would result in impacts that would extend well beyond a 50-year implementation period. For example, all alternatives would generate SNF and/or high-level waste (HLW) which would need to be managed for hundreds and potentially thousands of years. The PEIS assesses the impacts of disposing of this SNF and/or HLW in a future geologic repository. In addition the closed fuel cycle alternatives could result in a disposition option to store cesium and strontium for more than 50 years. The PEIS analyzes the impacts for such storage in Chapter 4, Section 4.3.3. The PEIS recognizes that for each additional year of operation beyond the 50-year implementation period, SNF and/or HLW would be generated and require management. The potential impacts associated with such operations would be similar in nature to the impacts presented for the 50-year implementation period.

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